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MECHANICAL DESIGN OF THE ELECTRONIC TURN-ON TIMER FOR THE M732 --ETC(U)

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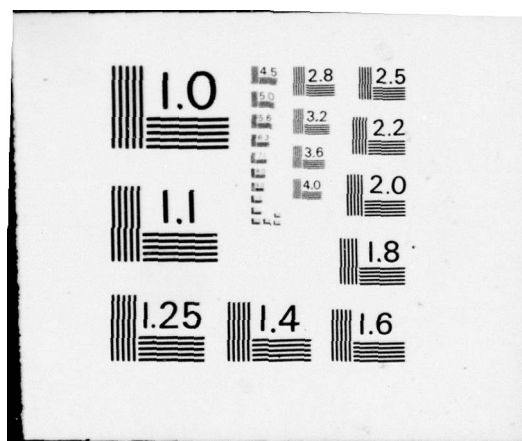
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**Mechanical Design of the
Electronic Turn-On Timer for the M732 Proximity Fuze**

September 1976

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**U.S. Army Materiel Development
and Readiness Command
HARRY DIAMOND LABORATORIES
Adelphi, Maryland 20783**

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1. INTRODUCTION

The M732 Artillery Proximity Fuze (fig. 1) was designed for use on all high-explosive (HE) shells fired from 105-, 155-, and 175-mm and 8-in. artillery weapons and from the 4.2-in. mortar. The M732 fuze is called a short-intrusion fuze because it has the same 2.2-in. intrusion as current point-detonating (PD) fuzes. The present standard proximity fuze, the M728, has an 8.7-in. intrusion. All HE projectiles must therefore be made with a deep cavity to accept the long intrusion. A removable supplementary charge is included in each HE projectile to fill the cavity when a short-intrusion fuze is used. In addition to substantial cost savings from elimination of the supplementary charge, the M732 fuze is expected to be less costly than the M728 fuze and provide better performance.

The electronic turn-on timer in the M732 fuze delays application of battery power to the electronic head until approximately 5 s before the projectile arrives at the target. By delaying turn-on, the electronic timer conserves power-supply energy, decreases the exposure to electronic countermeasures, allows the fuze to be fired closely over obstacles such as hills, and contributes to overhead safety across friendly territory.

In figure 1, the electronic timer is called the timer housing assembly, and the timer-setting element is called the detonator block assembly.

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M 732 FUZE CONFIGURATION

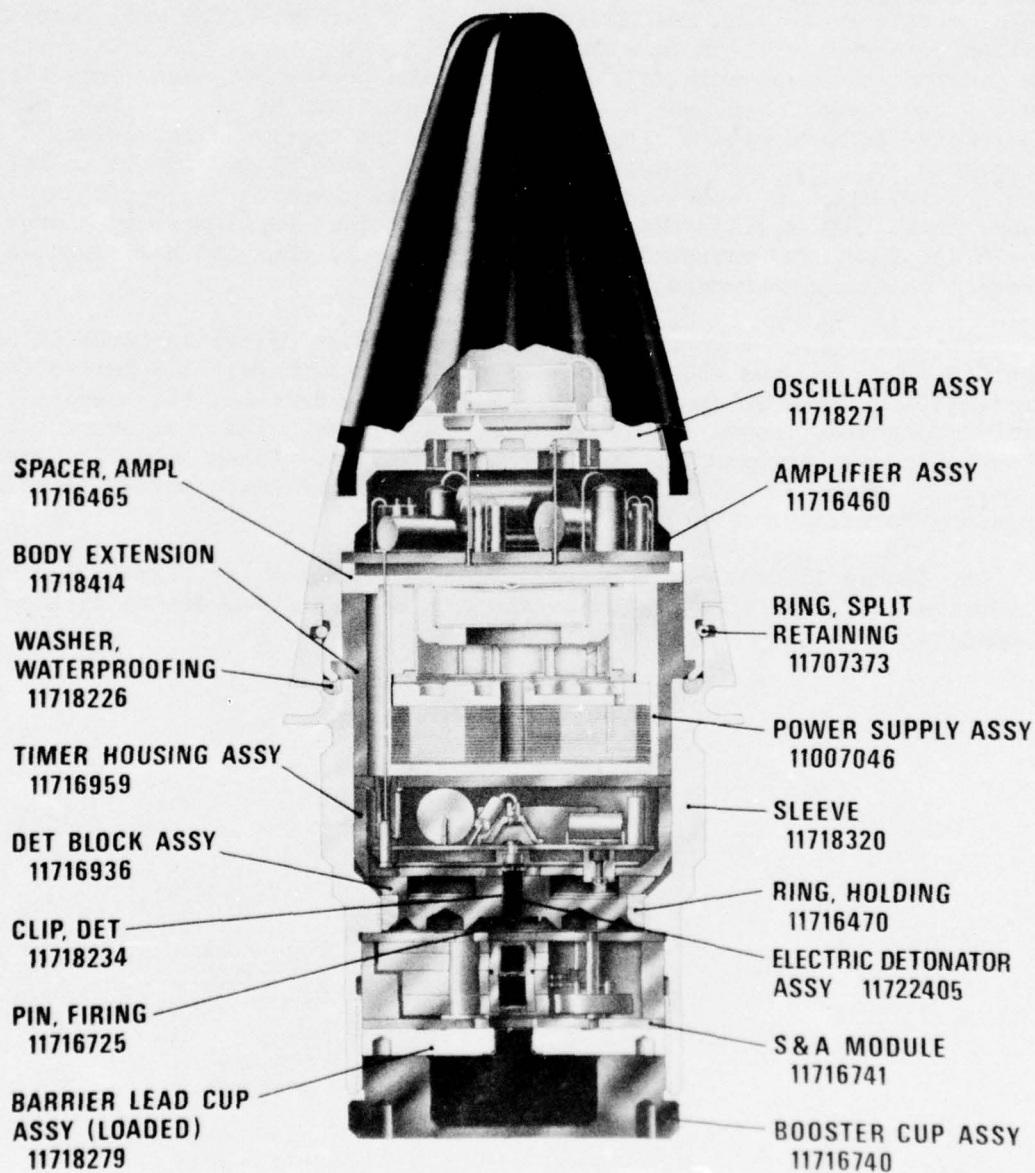


Figure 1. The M732 fuze.

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2. MECHANICAL-DESIGN REQUIREMENTS

Most of these mechanical-design requirements are from the M732 fuze requirements document, and the remainder come from experience during the development of other artillery fuzes:

- a. Lowest possible cost
- b. Settability by rotation of the nose of the fuze
- c. Settability in either direction up to 25 times without degradation
- d. Ten years or more storage over the temperature range of -50 to +70°C without degradation
- e. Accommodation of the electrical design by providing ready connection and accessibility to test points
- f. Survivability and reliable operation after the following environments:
 - (1) Setback acceleration of 30,000 g
 - (2) Lateral (sideslap) acceleration of 15,000 g
 - (3) Seven-foot drop per Test 111, MIL-STD-331, Environmental and Performance Tests for Fuzes and Fuze Components¹
 - (4) Transportation vibration per Test 104, Procedure II, MIL-STD-331¹
 - (5) Thermal shock per Test 113, MIL-STD-331¹
 - (6) Humidity per Method 103, Test Condition B, MIL-STD-202, Test Methods for Electronic and Electrical Component Parts²
- g. Reliable operation during the following environments:
 - (1) Spinning at 500 rps
 - (2) Temperature between -40 and +60°C.

¹MIL-STD-331, Environmental and Performance Tests for Fuzes and Fuze Components, U.S. Department of Defense (10 January 1966).

²MIL-STD-202, Test Methods for Electronic and Electrical Component Parts, U.S. Department of Defense (10 April 1973).

These requirements are severe, but they are necessary to assure reliable, accurate performance in the artillery environment over the military temperature range.

3. DESCRIPTION OF CURRENT DESIGN

The current design is described by the technical data package titled Timer Housing Assembly, 11716959, revision E, dated 5 June 1974. This design underwent development testing and was type classified on 5 February 1976. The electronic operation of the timer is described by Robert I. Christopherson.³

An exploded view of the current design is shown in figure 2. The timer housing and top plate provide the primary structural support with the 18-lb/ft³ polyurethane foam used as an encapsulant. The other parts in the timer perform functions such as electrical connections, sealing against potting leakage, electrical insulation, and timing.

TIMER HOUSING ASSEMBLY 11716959

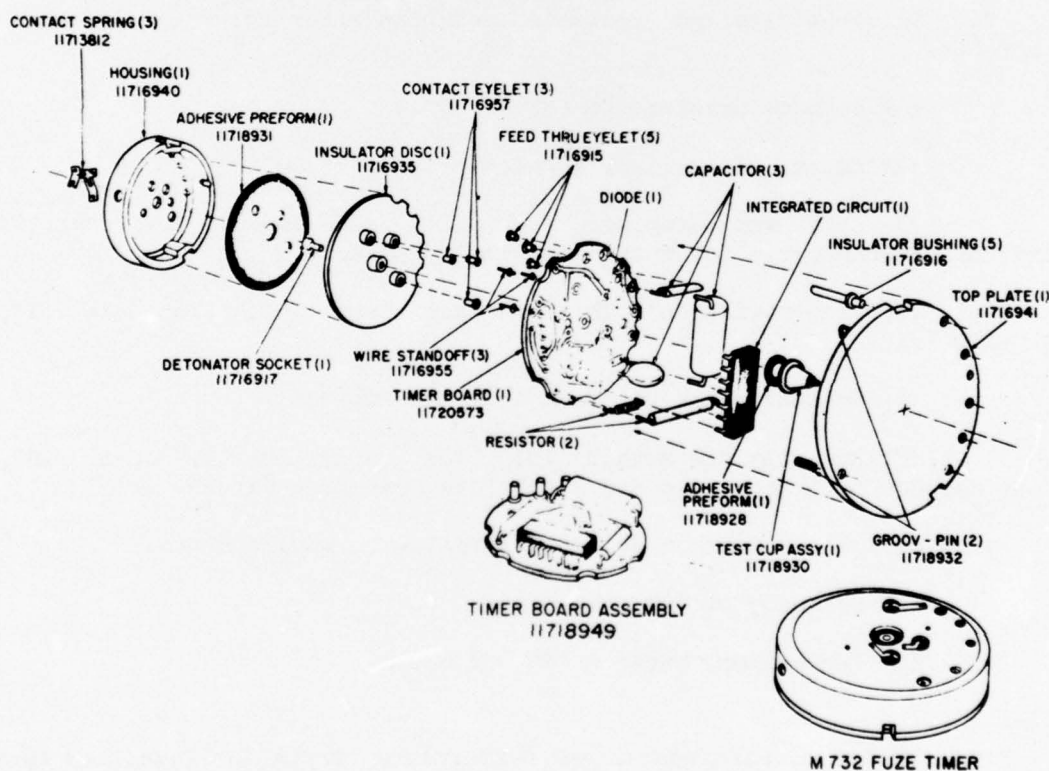


Figure 2. Current timer design.

³Robert I. Christopherson, *Proceedings of the Joint Technical Coordinating Group/Air-Launched Non-Nuclear Ordnance Electronic Fuze Symposium* (26-27 November 1973).

Fabrication of the timer consists of manufacturing several subassemblies and combining them into the final timer housing assembly. The top plate assembly (fig. 3) consists of the top plate, five insulator bushings, and two groov-pins. The top plate is a 1/16-in.-thick stamped aluminum part. The insulator bushings provide insulation for five wires from the power supply and electronics in the fuze nose, and they seal the top plate and the five feed-through eyelets against potting leakage. The insulator bushings are molded from a tetrafluoroethylene (TFE) type of material (brand name, KEL-F). This material was selected because of its flexibility and heat resistance. When the five wires are soldered to the feed-through eyelets, the insulator bushings must withstand the heat. Two groov-pins align and hold the top plate assembly to the housing. This type of pin was chosen instead of a dowel pin because it does not require a precision hole in the top plate.

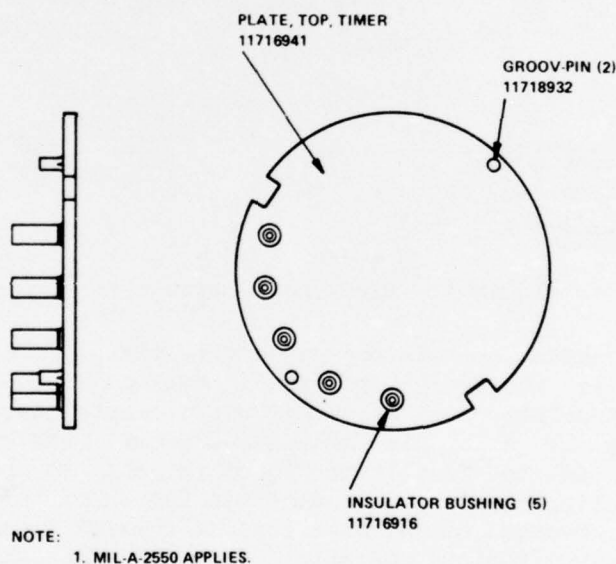


Figure 3. Top plate assembly.

The timer board assembly shown in figure 4 consists of a single, custom integrated circuit and assorted electrical components soldered onto a double-sided, plated-through-hole printed-circuit board. The printed-circuit board is designed to minimize errors in time-out caused by leakage currents. The electrical components are placed orthogonally to ease numerically controlled insertion during high-volume production. The five feed-through eyelets are held in position only by being soldered to the printed-circuit board. Three wire standoffs that connect the spring contacts to the timer circuitry protrude from the bottom of the printed-circuit board.

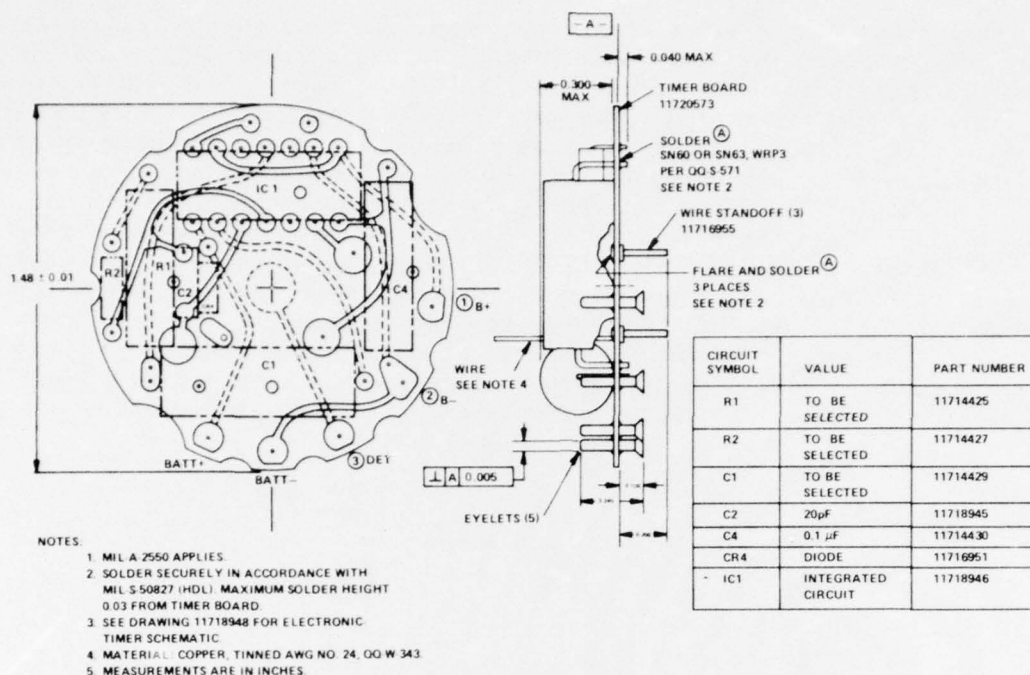
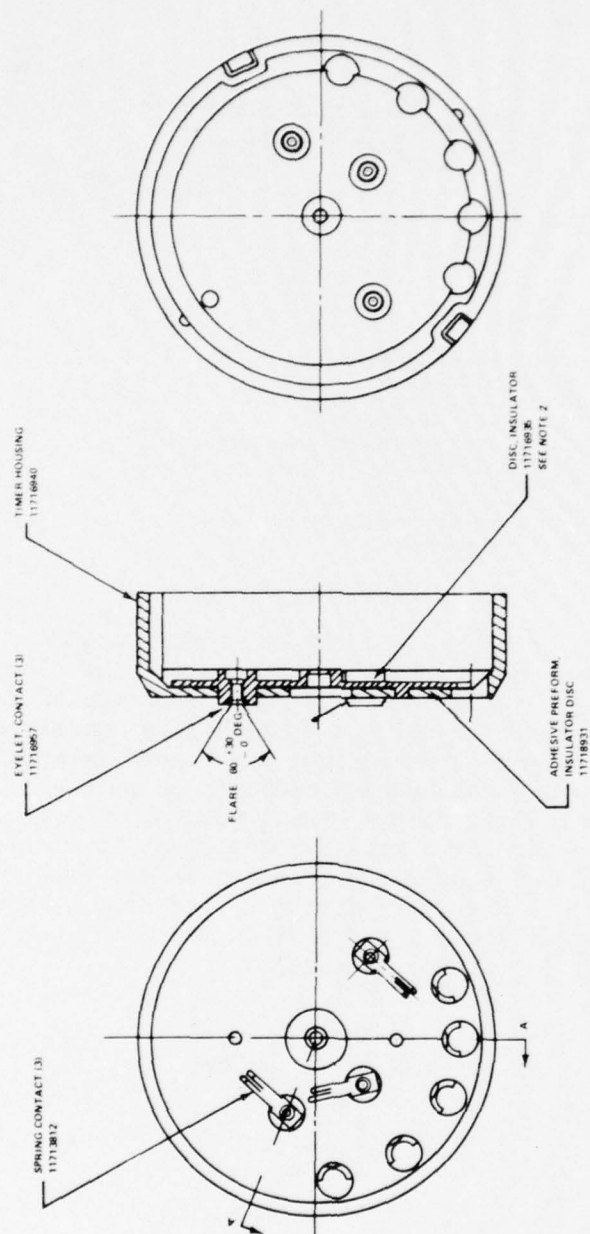


Figure 4. Timer board assembly.

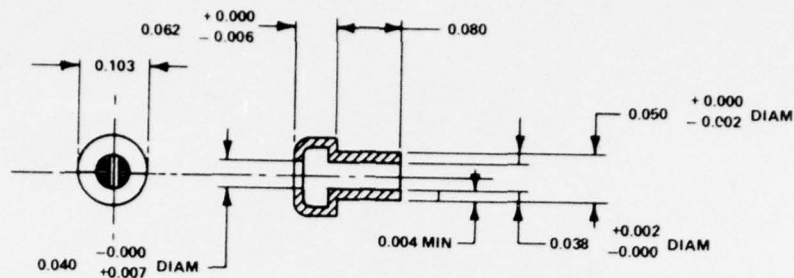
Flaring the contact eyelets to secure the spring contacts to the insulator disc is the final operation in making a contact assembly (fig. 5). The insulator disc was previously cemented into the diecast aluminum housing by using an adhesive preform. The purpose of the adhesive preform is to facilitate handling and to prevent potting leakage. Originally, the insulator disc and insulator bushings were the same material. Because of the high cost of the TFE material, a switch was made to diallyl pthalate material for the insulator disc. The insulator disc provides mechanical support for the spring contacts and must withstand soldering heat when the wire standoffs are soldered to the contact eyelets and spring contacts. The spring contacts are made of 0.007-in.-thick heat-treated beryllium copper clad with a 0.001-in. precious-metal alloy overlay for the actual contact surface. The spring contacts maintain a force of 50 to 150 grams over the tolerance range of the assembled parts. The structural details of the spring contact have been analyzed (Harry Diamond Laboratories--HDL--laboratory notebook No. 4081, p. 35). Two fingers are used for reliability, and under spin conditions the contact increases slightly (approximately 4 grams at 500 rps) to insure good contact.

The final assembly is started by placing the timer board assembly into the contact assembly. The detonator socket (fig. 6) is inserted into a recess in the insulator disc and through the printed-circuit



- NOTES
1. MIL A 2550 APPLIES
 2. TO CURE THE INSULATOR DISC ADHESIVE PREFORM (1171893) USE 50 ± 8 PIN CLAMPING PRESSURE AND MAINTAIN THE PARTS AT A TEMPERATURE OF 230 ± 25°F FOR A MINIMUM OF 5 MINUTES SO THAT THE TIMER HOUSING (1171894) AND THE INSULATOR DISC (1171893) ARE BONDED TOGETHER. ALLOW THE PARTS TO COOL TO 100°F BEFORE RELEASING CLAMPING PRESSURE

Figure 5. Contact assembly.

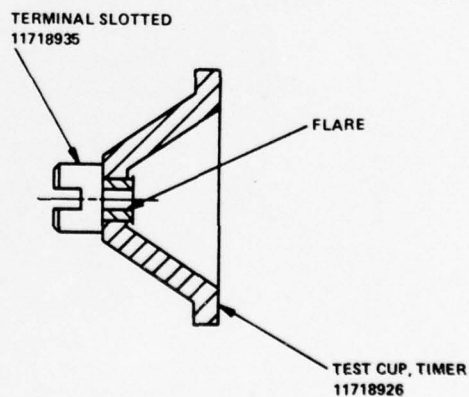


NOTES:

1. MIL-A-2550 APPLIES.
2. MATERIAL:
 - a. BODY-COPPER ALLOY NO. 260 HALF HARD IN ACCORDANCE WITH ASTM B 134.
 - b. SPRING CONTACT - STAINLESS STEEL 302 IN ACCORDANCE WITH ASTM A 313.
3. FINISH 1.11.2 of MIL-STD-171 0.000020 THICK MINIMUM.
4. APPROVED SOURCE OF SUPPLY:
PYLON COMPANY, INC.,
ATTLEBORO, MA,
VENDOR PART NO. 2024 S (MODIFIED) OR EQUIVALENT.
5. MEASUREMENTS ARE IN INCHES.

Figure 6. Detonator socket.

board. The detonator socket is flared and soldered to the printed-circuit board. Next, the test cup with the test terminal (fig. 7) at its top is centered over the detonator socket and cemented to the printed-circuit board by using a double-sided pressure-sensitive adhesive preform. A wire connecting the test terminal to the printed-circuit board is installed and soldered at both ends. The top plate assembly is then pressed on the timer housing. The five insulator bushings fit snugly over the five feed-through eyelets, and the groov-pins fit into shallow half-round recesses in the wall of the timer housing. The assembly is then turned over so the wire standoffs can be soldered to the contact eyelets and spring contacts. Encapsulation



NOTE:

1. MIL-A-2550 APPLIES.

Figure 7. Test cup assembly.

through a hole in the timer housing wall by using 18-lb/ft polyurethane foam is the final operation. The timers are clamped in potting fixtures (fig. 8) with silicone rubber plugs sealing the flanges of the feed-through eyelets and the holes in the timer housing assembly. The encapsulant is injected into the timer housing through a hole in the side wall. The encapsulant consists of two liquid components, which foam after being mixed. The foam cures in about 24 hr at room temperature, but exposing the foam first to 140°F for 2 hr shortens the cure time. Epoxy encapsulants have been tried without success because of electrical characteristics, long cure time, and mechanical deficiencies from -40 to +60°C. Figure 9 shows the timer housing assembly, and figure 10 shows the actual hardware.

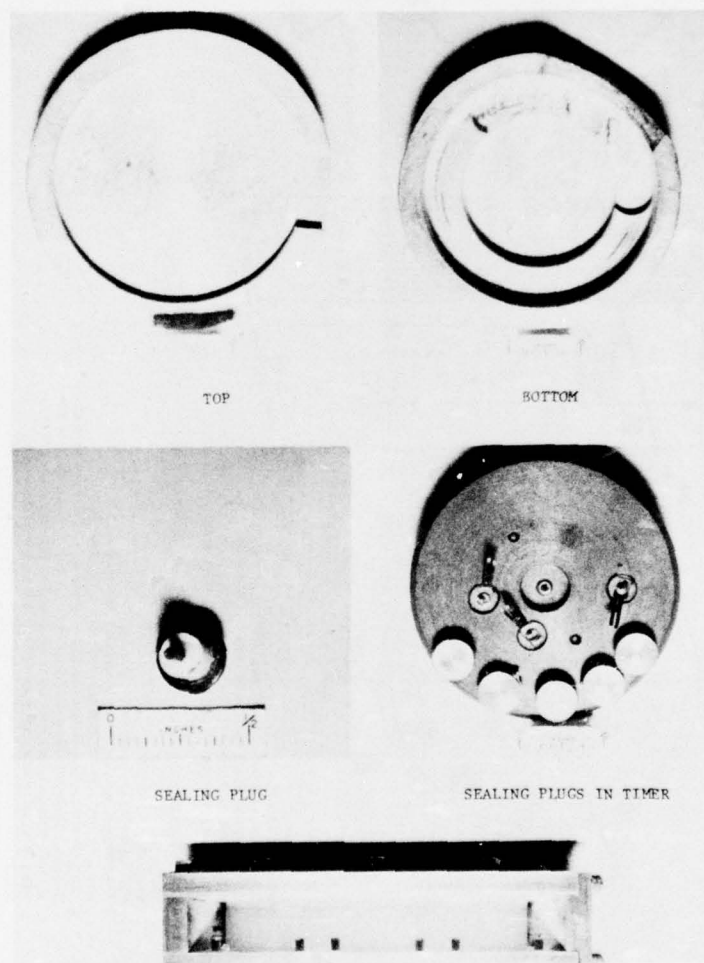


Figure 8. Potting hardware.

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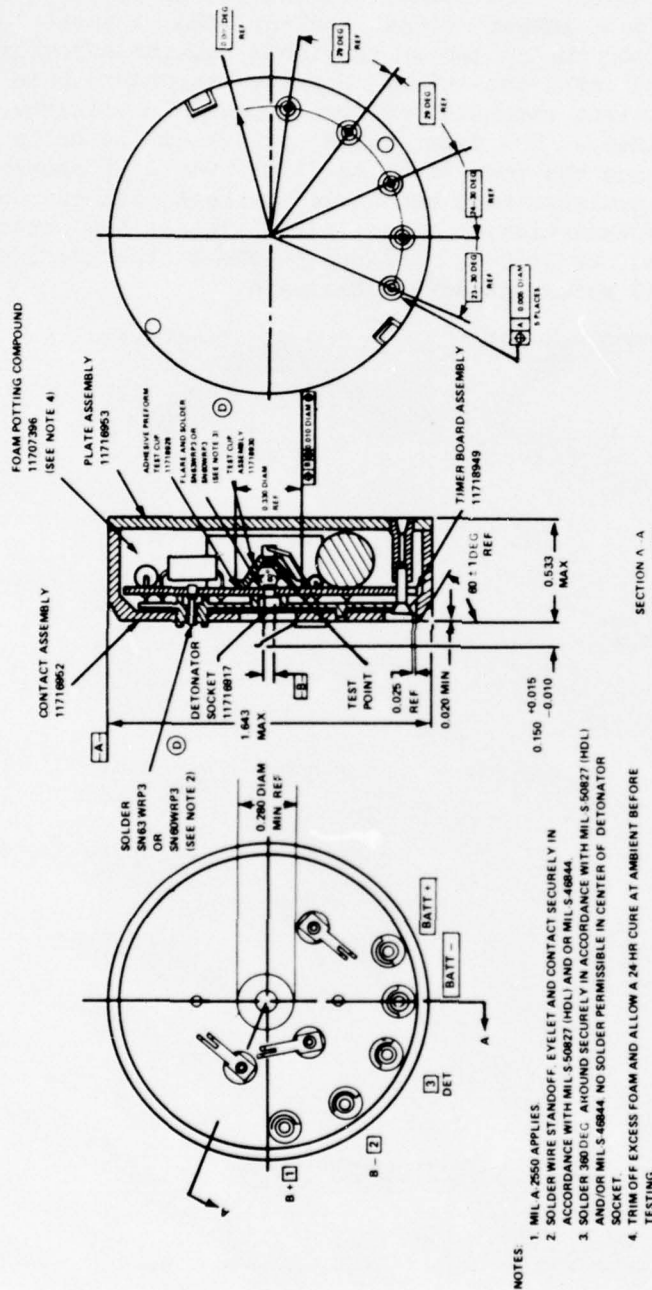


Figure 9. Timer housing assembly.

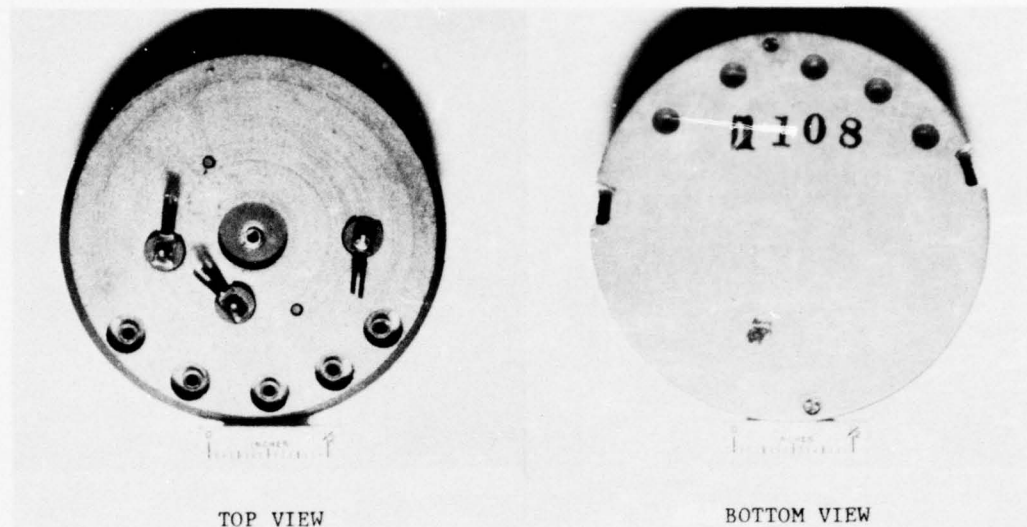


Figure 10. Current timer design.

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The detonator block assembly consists of a detonator block, a ratiometer, and adhesive bonding the two. Figure 11 shows a completed detonator block assembly. Figures 12 and 13 show thick-film and thin-film ratiometers, respectively. The detonator block is machined from steel-bar stock and plated with electroless nickel for corrosion resistance.

To assemble the timer into the fuze, the five wires from the forward portion of the fuze are pushed through the five feed-through eyelets, and the timer housing assembly is pressed onto the body extension. The five leads are then soldered to the feed-through eyelets and clipped to the proper length. Recesses in the side wall of the timer housing are an interference fit with the tangs on the body extension. The tangs transmit torque to drive the timer when the fuze is rotated to set the time. The fuze assembly is called a turning capsule assembly (fig. 14) at this point.

The next step is to place a detonator block assembly into the fuze sleeve with a holding ring. The turning capsule assembly is then pressed into the sleeve mating the hub of the detonator block assembly with the hole in the timer. The turning capsule assembly is secured by tightening four setscrews against the split retaining ring. The holding ring is then tightened, clamping the detonator block assembly against the timer. Epoxy on the threads fastens the holding ring to the fuze sleeve. The fuze assembly at this point is called an electronic assembly (fig. 15).

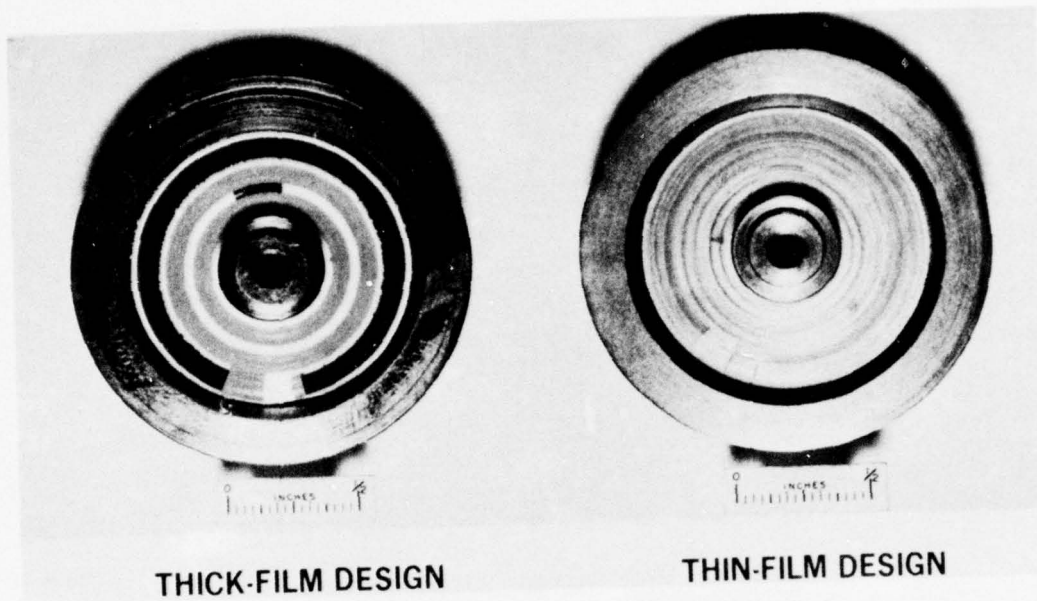


Figure 11. Detonator block assembly.

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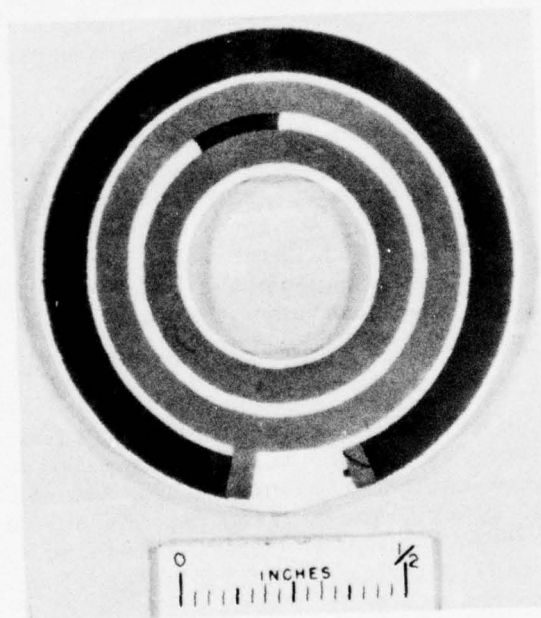


Figure 12. Thick-film ratiometer.

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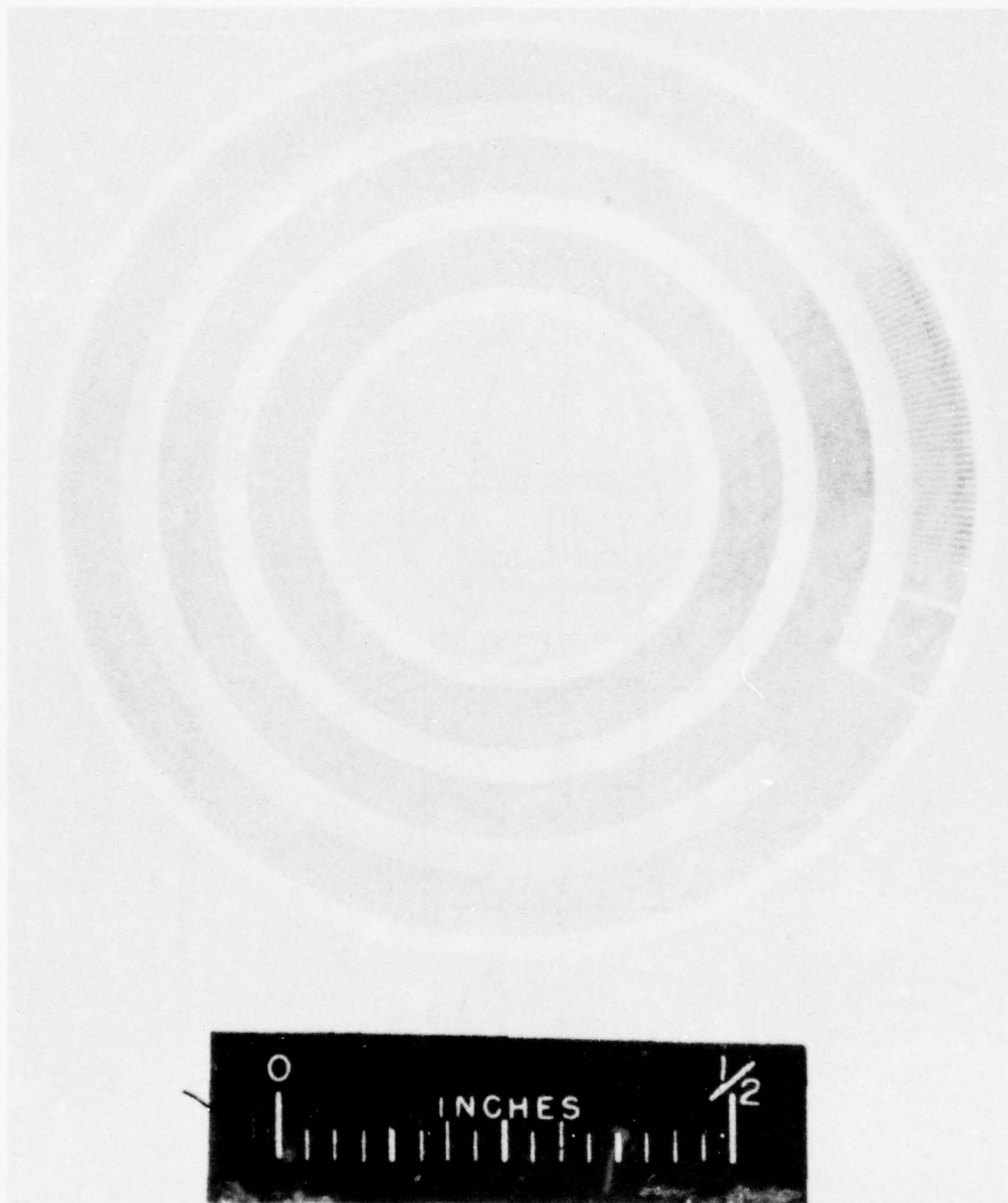
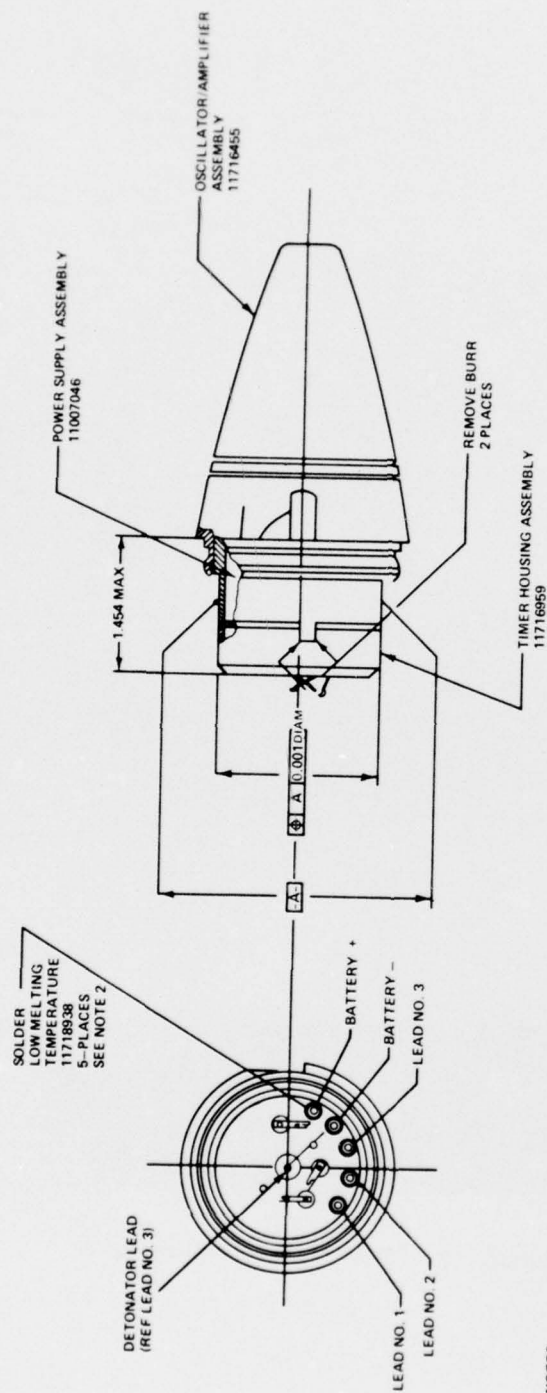


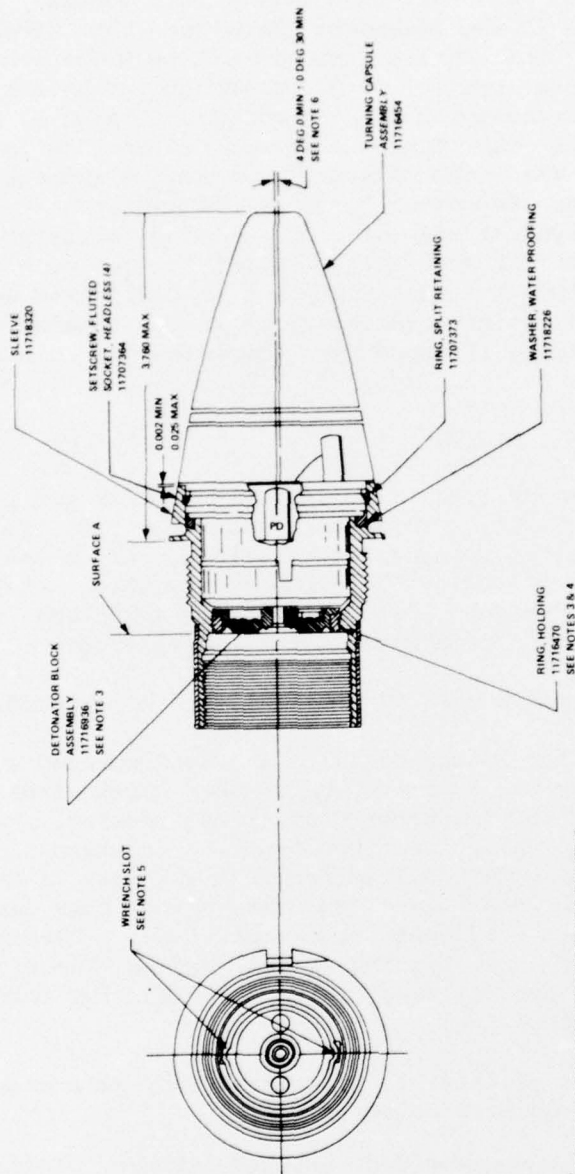
Figure 13. Thin-film ratiometer.

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- NOTES:
1. MIL A 2550 APPLIES
 2. SOLDER SECURELY IN ACCORDANCE WITH MIL S 50827.
 3. MEASUREMENTS ARE IN INCHES.

Figure 14. Turning capsule assembly.



NOTES

1. MIL A 2550 APPLIES
2. TURNING CAPSULE ASSEMBLY IS TO BE SEATED IN SLEEVE BY A 500 TO 1,000 LB LOAD WHILE SETSCREWS ARE UNIFORMLY TIGHTENED. RESULTANT TURNING TORQUE AT TIME SETTING JOINT WITH SEATING LOAD REMOVED SHALL BE 100 TO 200 IN.-LB.
- CAUTION: BEFORE INSERTING TURNING CAPSULE ASSEMBLY INTO SLEEVE, CHECK TO MAKE SURE THAT HOLDING RING IS PROPERLY INSERTED INTO SLEEVE.
3. DETONATOR BLOCK ASSEMBLY AND HOLDING RING SHALL NOT PROTRUDE BEYOND SURFACE A.
4. BEFORE ASSEMBLING HOLDING RING COAT TWO THREADS AT WRENCH SLOT END WITH ADHESIVE COMPOUND. 11707389. THREAD HOLDING RING UP AGAINST DETONATOR BLOCK ASSEMBLY.
- CAUTION: DO NOT LIFT TURNING CAPSULE ASSEMBLY OFF OF ITS SEAT IN SLEEVE AFTER ADHESIVE COMPOUND IS FULLY CURED. TORQUE OF 55 : 5 IN.-LB APPLIED IN LOOSENING DIRECTION SHALL NOT MOVE HOLDING RING.

5. TURNING CAPSULE ASSEMBLY AND SLEEVE SHALL BE ANGULARLY ALIGNED BY USING ALIGNMENT FIXTURE. 1104296. ALIGNMENT FIXTURE MEANS FOR ROTATING DETONATOR BLOCK ASSEMBLY AND TURNING CAPSULE ASSEMBLY INTO BACK END OF ASSEMBLY. TURNING CAPSULE ASSEMBLY SHALL BE TURNED INTO BACK END OF ASSEMBLY. TURNING CAPSULE ASSEMBLY SHALL BE EITHER CONTINUOUSLY ON OR FLASHING. ROTATE DETONATOR BLOCK ASSEMBLY CLOCKWISE UNTIL FLASHING INDICATOR LAMP JUST GOES OFF IN THIS POSITION. STAKE DETONATOR BLOCK ASSEMBLY RIM INTO HOLDING RING WHICH WITHOUT MOVING.
6. THE 4°0' - 0°30' IS MEASURED BETWEEN CENTER OF SETTING SLOT ON SLEEVE AND SETTING LINE ON BODY. THIS DIMENSION IS PRIOR TO SETTING RATIONMETER.
7. MEASUREMENTS ARE IN INCHES.

Figure 15. Electronic assembly.

After setting the turning capsule assembly to the zero alignment position on the sleeve, a small (0.035-in. o.d.) coaxial probe is inserted through the hole in the detonator block into the timer through the detonator socket. The outside sheath of the probe contacts the detonator socket, and the center conductor of the probe contacts the timer test point. The detonator block assembly is rotated by using two holes in the bottom while the timer electronics are being powered through the test point. When the electrical zero alignment point is sensed, the flange on the detonator block is crimped into the slots in the holding ring. The physical end of the setting resistor on the ratiometer is the electrical zero alignment point. The zero alignment could be done mechanically, but inaccuracy would result from mechanical tolerance buildup that is eliminated by electrical sensing after the parts are assembled. Loading of explosives completes the fuze assembly.

4. DESIGN AND PRODUCTION PROBLEMS

Three approaches were employed to solve the design and production problems that arose. First, the part or assembly was redesigned. Second, the production method was modified. Third, as a last resort, stringent controls were placed on the production method. Later, the timer was completely redesigned. The following problems with the current timer design are in approximate chronological order.

Problem 1.--The foam potting leaked where it was not wanted.

Solution.--The insulator bushings sealed the feed-through eyelets on one end and sealed the top plate holes where the wires from the fuze entered. Adhesive bonded the insulator disc to the housing. The rubber plugs and pins (fig. 8) sealed the flanges of the feedthrough eyelets and the holes in the timer housing. The rubber plugs were a continuing problem. They could be used only a few times before they had to be discarded, and they were difficult to manufacture. Cleaning foam potting from timers and the potting molds was a laborious hand operation. The technique and fixtures currently used for foam potting were adequate, but time consuming.

Problem 2.--The timers failed to work after they were assembled to the fuzes and the five wires were soldered.

Solution.--Originally, double-sided printed-circuit boards without plated-through holes were used in timers. Soldering the feed-through eyelets on both sides of the printed-circuit board connected the sides. Soldering the five feed-through wires at the fuze assembly resulted in solder reflow at the timer printed-circuit board. Also, because a dull drill had been used to drill holes in the printed-circuit board, a chamfering tool had been applied to each hole to clean up the burrs

caused by the dull drill. This cleanup operation left an insulating ring around the hole in the center of each printed-circuit board pad. This insulating ring was bridged when the feed-through eyelets were soldered to the printed circuit, but when reflow occurred later in the fuze assembly, an open circuit connection resulted. Two courses of action were followed to eliminate this problem. The first was to change to a plated-through-hole type of printed-circuit board to provide a more reliable connection between both sides, even if solder reflow occurred. The second was to specify a low-melting-point solder for soldering the five wires to the feed-through eyelets to minimize possible solder reflow at the timer printed-circuit board.

Problem 3.--The cadmium plating on the detonator block was flaking off and found lying on the ratiometer. These pieces of metal could short the ratiometer and affect timer performance.

Solution.--The anodizing of the timer housing gave it an extremely hard and abrasive surface. At the five holes where the feed-through eyelet connections were made, the edges of the holes were scraping the cadmium plating off the detonator block. The anodizing of the timer housing could not be changed readily. Several platings were tried on the detonator block, and electroless nickel was selected because it did not flake off or wear when rotated against the anodized timer housing.

Problem 4.--The insulator bushings molded by an outside vendor were brittle, discolored, and unacceptable.

Solution.--The HDL molding of the insulator bushings was successful. When The General Electric Company (GE) attempted to buy insulator bushings from a commercial vendor, he could not deliver acceptable parts. The commercial vendor was using the sprues, etc., from each mold cycle together with virgin material. The HDL practice is never to use anything except virgin material. Commercial practice is to reuse scrap with virgin material to lower cost. This TFE material responds unfavorably to being reused and requires close temperature control even if only virgin material is being used. Because the commercial vendor was unsuccessful, GE had the parts made on a screw machine using molded bar stock of virgin TFE. In the future, molding of these parts will require that HDL keep in close contact with a molding vendor to insure a quality product.

Problem 5.--After exposure to +60°C, the top plates were lifted as much as 1/16 in. above the timer housing. This rise caused the timer to fail the height specification.

Solution.--Growth of the polyurethane foam encapsulation was the cause of top plate lifting. An incomplete cure caused by an improper ratio between the two components of the foam potting was suspected as

the cause. But HDL tests did not substantiate this theory. A 2- to 4-hr soak at +70°C with the timer clamped in the potting fixture solved the problem. Timers that had foam potting cured by this method did not exhibit top plate lifting during later temperature exposure. It was suspected that the liberal use of methyl-ethyl-ketone (MEK) solvent to clean off foam potting after removal of the timer from the potting fixtures was contributing to the problem. Careful use of MEK was ordered. These changes eliminated this problem.

Problem 6.--Test cup terminals (fig. 7) were received locked in pairs. They could be separated only with difficulty, causing a lot of unnecessary work.

Solution.--The problem resulted from the intermeshing of two terminals because the slot dimension was slightly larger than the fingers. During barrel plating, the two parts became plated together and difficult to separate. The solution was to change the dimensions of the part so that the fingers and slot could not fit together.

Problem 7.--The timers were observed to have cracked insulator discs where the detonator block mated with the timer.

Solution.--An inexperienced operator had pressed the test cup too forcefully onto the printed-circuit board. A stop was added to the assembly tooling to eliminate this problem.

Problem 8.--Flaring of the detonator socket split the wall of the socket.

Solution.--A 60-deg flare had been specified on the drawing. Tests at HDL showed that a 30-deg flare was adequate. Examination of the detonator sockets showed that they were made from harder material than the drawing specified, and the hole was not concentric with the outside diameter, drastically decreasing the wall thickness. The problem was solved by using the 30-deg flare and having the vendor replace the detonator sockets with eccentric holes.

Problem 9.--After assembly and encapsulation, timer housing assemblies or timer housings alone did not pass the outside-diameter gage test.

Solution.--The timer housings were manufactured in a bell-mouth condition. Since they had been received and anodized, nothing could be done quickly except sorting out the ones that would not fit through the gage. The groov-pins in the top plate were spreading the housing so that the unit did not fit through the gage. A fixture was made that squeezed the unpotted timer housing assembly to the proper dimension. The solution was time consuming, but effective.

Problem 10.--Flaring the contact eyelet sheared it off against the edge of the spring contact.

Solution.--The spring contact is a stamped metal part with sharp edges. In the hole of the spring contact, they were shearing the contact eyelet when it was flared to secure the spring contact. Control of the flaring angle and pressure solved this problem.

Problem 11.--Adhesive used to bond the insulator disc was observed in the center hole of the timer housing.

Solution.--The hole in the adhesive preform was enlarged and the pressure was controlled to minimize squeeze out.

Problem 12.--Body extensions manufactured by the fuze contractor did not mate with timer housing assemblies.

Solution.--The body extensions were defective in manufacture. Since the defective body extensions were already on fuzes, it was decided that modification of the timer housing assemblies would be the easiest way to solve the problem. A chamfer was filed on each edge of the notches in the top plate where the tangs on the body extension passed through. This modification allowed the defective body extensions to be used until the fuze manufacturer could procure acceptable material.

Problem 13.--X raying timer housing assemblies showed that some had wire clippings inside.

Solution.--The first explanation from the contractor was that the inspected units were across the bench from lead clipping operations and that some clippings apparently had landed on the already inspected units. A rearrangement of the assembly and inspection stations eliminated the problem. A second occurrence of this problem was found to be from the wire jumper from the test point to the printed-circuit board. This jumper probably caused the problem the first time, also. Careful inspection before foam potting was the only solution to this problem.

5. DESCRIPTION OF IMPROVED DESIGN

The new design is described by the technical data package titled timer assembly, dated 14 December 1973.

An exploded view of the improved timer design is shown in figure 16. The design and production problems with the current configuration have been almost totally eliminated by the new, improved design. It has approximately half the parts count of

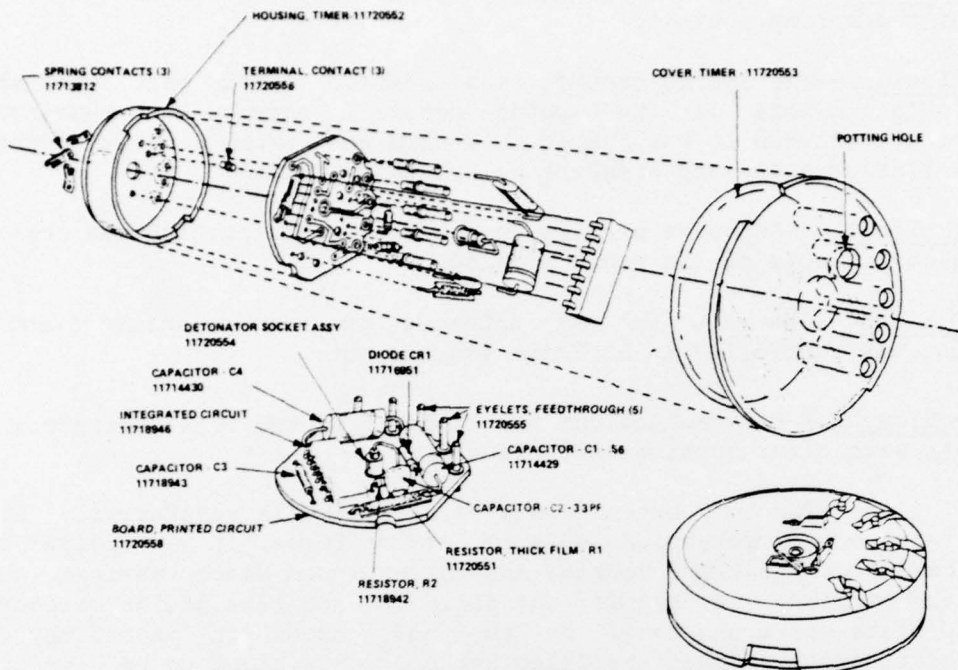


Figure 16. Improved timer design.

for mechanized assembly, and will cost much less (HDL laboratory notebook No. 4595, p. 37). A contract was awarded to implement the detailed design and to fabricate the parts.⁴ Samples of the new design have been manufactured and tested. Analysis of these limited test data indicates that this improved design should easily meet the timer requirements. Approximately 2000 timers are currently being built into fuzes for field testing and evaluation.

The timer housing and cover still provide the primary structural support together with the polyurethane foam potting encapsulant. The timer housing is injection molded by using 40-percent glass-filled polycarbonate material. This eliminates many parts of the current design, the five feed-through eyelets can be sealed, and the raised walls around the spring contacts protect them from handling damage. Three contact terminals are inserted and ultrasonically bonded into the timer housing to provide electrical and mechanical connection to the spring contacts and printed-circuit board.

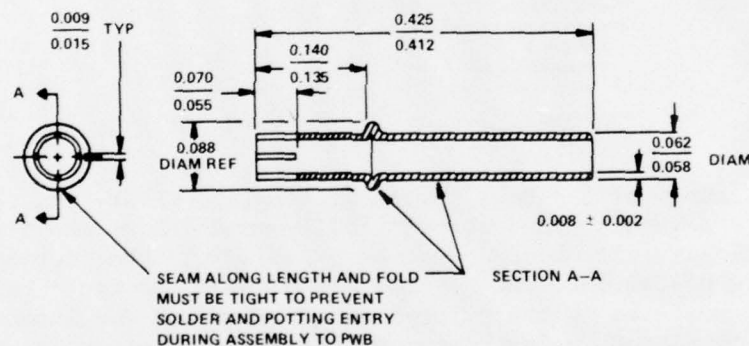
⁴Product Improvement of the XM732 Electronic Timer, Final Technical Report, General Electric Co., Aerospace Electronic Systems Department, under contract DAAG-73-C-0087, Utica, NY (January 1974).

The new timer cover is an injection-molded part of the same material as the timer housing. The insulator-bushing function is now part of the top cover. The five feed-through eyelets are swaged slightly in the holes in the top cover to be sealed against potting leakage.

Figure 17 shows the new feed-through eyelet. It has a flange to locate its height on the printed-circuit board. It is designed also to be swaged out against the timer housing and cover, to seal against potting leakage. The eyelet and timer housing are designed also to accommodate automatic welding of the five wires from the fuze, instead of the present method of hand soldering.

A new part (fig. 18) was designed to replace the current costly detonator socket and test cup assembly and adhesive. The test-point terminal and wire jumper to the printed-circuit board are all part of the detonator socket assembly.

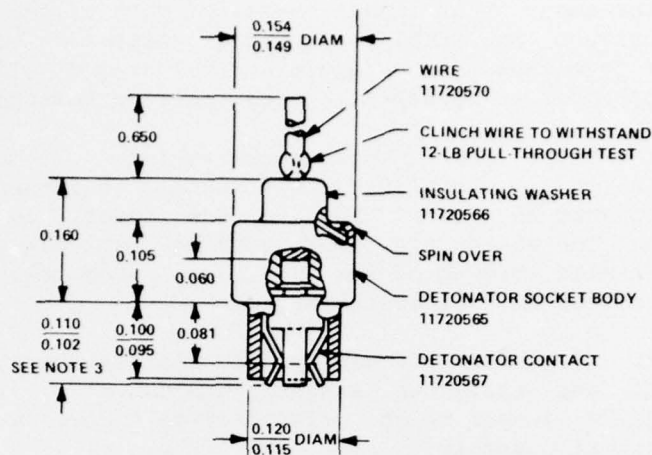
For cost reduction, a switch was made to a printed-circuit board by the additive instead of the subtractive process. A low temperature coefficient, thick-film, laser-trimmed resistor was substituted for the 2-megohm timing resistor and the trim resistor used in the current design.



NOTES:

1. MIL-A-2550 APPLIES.
 2. MATERIAL: NICKEL ALLOY TUBING IN ACCORDANCE WITH MIL-N-19153.
 3. FINISH: 1.8.1 OF MIL-STD-171, 0.00015 IN. THICK.
 4. MEASUREMENTS ARE IN INCHES.
- PREVIOUS SOURCE OF SUPPLY:
AMP INC.
HARRISBURG, PA

Figure 17. Timer eyelet.



NOTES:

1. CONTACT INSERTION FORCE: WHEN TESTED WITH SPHERICAL NOSE GAGE PINS. THE INSERTION FORCE SHALL BE 50 GRAMS MIN WITH 0.0300 ± 0.0003 DIAM PIN AND 250 GRAMS MAX WITH 0.0350 ± 0.0003 DIAM PIN.
2. ITEM IDENTIFICATION MARKING SHALL BE IN ACCORDANCE WITH MIL-STD-130.
3. 0.110 / 0.102 DIMENSION TO BE WITH STEEL PIN INSERTED PER NOTE 1.

4. MEASUREMENTS ARE IN INCHES.

PREVIOUS SOURCE OF SUPPLY:

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Figure 18. Detonator socket assembly.

The assembly of the new design is simple. First, the three contact terminals are inserted and ultrasonically bonded into the timer housing. The printed-circuit board assembly including the detonator socket assembly is placed into the housing. The three contact terminals are flared and soldered to the printed-circuit board. The detonator socket assembly is flared against the timer housing. The spring contacts are placed on the contact terminals, which are flared and soldered to the spring contacts. The top cover is cemented to the housing with epoxy, and the five feed-through eyelets are swaged against the holes in the cover to seal against potting. (Ultrasonic bonding of the cover was attempted. It was not satisfactory because the ultrasonic energy was transmitted down the feed-through eyelets through the timer circuitry into the integrated circuit and burned out the integrated circuit.) The final operation is to encapsulate the timer assembly through a hole in the top cover. This can be done in the new design without the need for fixtures or sealing plugs.

The detonator block assembly was improved by making the recess shallower. This depth stiffens the detonator block, providing better support for the ratiometer. Cadmium plating can again be used instead of more costly electroless nickel, because the plastic housing does not abrade the cadmium plating.

The new timer assembly (fig. 19) and detonator block assembly are assembled into the fuze exactly as in the current design. The molded top cover of the new design has a chamfer molded in so that if the body extension is defective in this area, it can still be used. The slots in the new design are 180 deg apart to simplify manufacture of the body extension tangs by having them in line. The five wires from the fuze to the feed-through eyelets can be welded with the new design. Slots are provided in the timer housing for access by welding electrodes.

The current and new timer assemblies can be compared in figure 20.

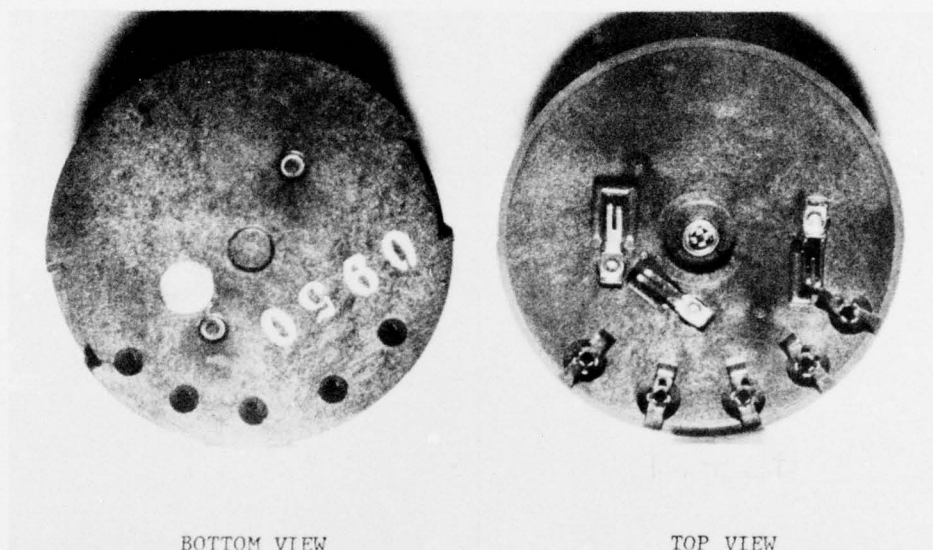
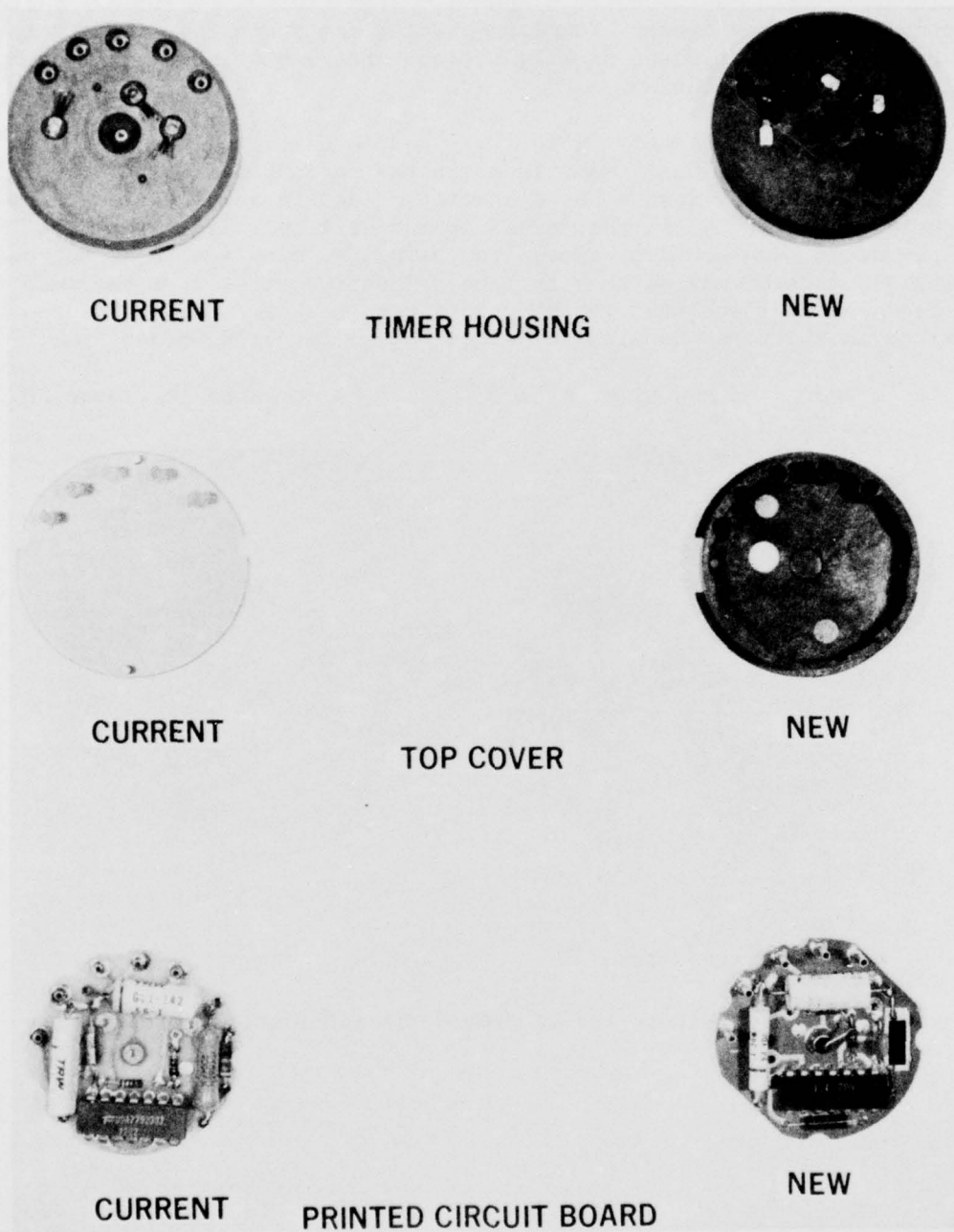


Figure 19. Improved timer design.

970-75



336-74

Figure 20. Current and new timer designs.

6. CONCLUSIONS

The current design has performed well, demonstrating over 98-percent reliability during actual gun firings. The improved design should improve this performance at a much lower cost.

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